REMARKS

Reconsideration of this application is respectfully requested. Claims 1 – 13 are pending in this application. Claims 11 – 13 are allowed and claims 1 – 10 stand rejected. Claims 6, 7 and 10 were objected to as being dependent on a rejected base claim but were indicated allowable if rewritten in independent form. No new mater has been added. The rejections set forth in the Office Action are respectfully traversed below.

Claim Amendments

Claims 4 and 6 have been amended to improve their form in accordance with U.S. practice. Approval and entry of the amendments to claims 4 and 6 are respectfully solicited.

Claim Rejections – 35 USC §102

Claims 1-5, 8 and 9 are rejected under 35 U.S.C §102(b) as being anticipated by **Matsumura et al.** (U.S. Patent No. 4,737,003). For the reasons set forth in detail below, this rejection is respectfully traversed.

The present invention is directed to a carrier injection type optical switch in which the refractive index of a semiconductor optical waveguide is changed by injecting carriers, thereby allowing the propagation path of an optical signal to be switched. More particularly, the present invention is directed to an optical switch that enables reduction in injected current by providing a structure in which injected carriers tend to be *accumulated* in a part where they will be effective.

As discussed on page 11, lines 9-16 of the present application, the change in refractive index of the semiconductor optical waveguide is inversely proportional to the effective mass of

PAGE 6/10 * RCVD AT 8/20/2004 1:48:08 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/0 * DNIS:8729306 * CSID:202 775 9242 * DURATION (mm-ss):05-18

the carriers. In an ordinary semiconductor, since electrons have a smaller effective mass than holes, a change in refractive index in the case of injecting electrons is larger than a change in refractive index in the case of injecting holes.

To provide a structure in which electrons, which cause a relatively large change in refractive index with change in concentration, tend to be accumulated in a waveguide layer, the present invention includes, for example, a p-type AlGaAs clad layer below a waveguide layer made of an n-type semiconductor (see, e.g., Fig 5 and page 11, line 22 – page 12, line 9). With the above-described structure, the accumulation effect of electrons in the waveguide can be increased.

Matsumura et al. disclose an optical switch including a compound semiconductor layer that changes its refractive index by changing its carrier concentration (see column 3, lines 26 – 39). The **Matsumura et al.** reference recognizes the technique of providing a P-N junction in a compound semiconductor layer and injecting carriers by causing forward current to flow, thereby changing the carrier concentration (see column 5, lines 21 -36).

The structure of the **Matsumura et al.** optical switch will now be described with reference to Figs. 7a -7g. As shown, e.g., in Fig. 7g, the optical switch includes a common electrode 31 on a bottom surface and an InP substrate 21 formed on the electrode 31. As shown in Figs. 7f and 7g, an InGaAsP layer 29 is formed on the substrate 21 and an InP layer 30 is formed on the layer 29 (see column 8, lines 36 - 45). The InGaAsP layer 29 forms the optical waveguides 25-1, 25-2, 26-1 and 26-2 (see column 8, lines 48 - 55).

PAGE 7/10 * RCVD AT 8/20/2004 1:48:08 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/0 * DNIS:8729306 * CSID:202 775 9242 * DURATION (mm-ss):05-18

Electrode stripes 24-1, 24-2, 24-3 and 24-4 are formed along the diagonals of the intersections of the optical waveguides 25-1 to 26-2. An InP clad layer 23 is formed beneath each of the stripe electrodes 24-1 to 24-4. A superlattice 22 formed of an InGaAsP layer and an InP layer is formed between the InP substrate 21 and InP clad layer 23 (see column 7, line 57 – column 8, line 2).

As described in column 6, lines 15 - 31 of **Matsumura et al.** the superlattice structure facilitates the injection of carriers (electrons, holes) better than a single layer structure. That is, more carriers are injected into the superlattice, thereby changing the refractive index of the superlattice.

A rejection under §102 requires that each and every claimed element must be disclosed exactly as claimed in the prior art reference. The Office Action asserts that the superlattice layer 22 corresponds to the claimed carrier accumulating layer in which injected carriers are accumulated (see Office Action, page 3, lines 6 -9). However, in contrast to the claimed invention, **Matsumura et al.** do not disclose or suggest *a carrier accumulating layer in which injected carriers are accumulated*, as recited in claim 1.

Although the **Matsumura et al.** reference discloses that the superlattice layer 22 facilitates carrier injection, and that more carriers are injected into the superlattice 22 than a single layer structure, the injection of a greater number of carriers does not necessarily correspond to an accumulation of the injected carriers. For example, in column 5, lines 30 – 35, **Matsumura et al.** recognize that the number of injected carriers can be increased by changing the current (i.e., the applied voltage). However, as explained in the Background Art section of

PAGE 8/10 * RCVD AT 8/20/2004 1:48:08 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/0 * DNIS:8729306 * CSID:202 775 9242 * DURATION (mm-ss):05-18

the present application (e.g., page 5, lines 2 – 13), increasing the number of injected carriers does not mean that the carriers are accumulated, and the carriers may easily flow out of the layer in which they are injected.

In the absence of any disclosure or suggestion of a carrier accumulating layer to accumulate injected carriers, it is respectfully submitted that the **Matsumura et al.** reference does not anticipate the invention recited in claim 1, and claims 2-4, 8 and 9, which depend therefrom. Reconsideration and withdrawal of the rejection of claims 1, 2 – 4, 8 and 9 under §102 are respectfully requested.

The Dependent Claims

The dependent claims recite additional features not disclosed or suggested by the cited prior art. For example, each of dependent claims 2 – 4 recite the relative band gaps of various layers. More particularly, claim 2 recites that the clad layer has a band gap broader than that of the waveguide layer; claim 3 recites a semiconductor layer having a band gap broader than that of the waveguide layer; and, claim 4 recites that the semiconductor layer having band gap broader than that of the waveguide layer is formed by a layer having different p/n polarity.

Matsumura et al. disclose that the superlattice layer 22 or a layer of InGaAsP used in place of the superlattice layer has a band gap corresponding to the wavelength of light 1.25 μm (see column 7, lines 62 -64 and column 9, lines 21 – 26). However, **Matsumura et al.** do not disclose or suggest the relative band gaps of the various layers, as recited in claims 2-4.

Therefore, claims 2 – 4 are allowable for these additional reasons.

Application No.: 10/763,277
Amendment Under 37 C.F.R. §1.111 dated August 20, 2004
Response to the Office Action of May 21, 2004

CONCLUSION

In view of the foregoing amendments and accompanying remarks, it is submitted that all pending claims are in condition for allowance. A prompt and favorable reconsideration of the rejection and an indication of allowability of all pending claims are earnestly solicited.

If the Examiner believes that there are any remaining issues to be addressed, the Examiner is requested to contact Applicant's undersigned attorney to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 50-2866

Respectfully Submitted,

WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP

William M. Schertler

William M. Schertler
Attorney for Applicant
Registration No.: 35,348

WMS:kal
1250 Connecticut Avenue
Suite 700
Washington, D.C. 20036
(202) 822-1100
Q:\2003\032179\Filings\1.111 Amendment - August 2004.doc

PAGE 10/10 * RCVD AT 8/20/2004 1:48:08 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/0 * DNIS:8729306 * CSID:202 775 9242 * DURATION (mm-ss):05-18